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ABSTRACT

One of the strongest arguments made to attract increased support for science for undergraduate liberal arts colleges in the mid- to late-1980s was that the proportion of students obtaining their Ph.D. degrees was larger at these institutions than at their Ph.D. granting university counterparts. This conclusion was supported by later research, but whether it remains meaningful today was one subject of research by the Research Corporation. The recent data compilation for the natural sciences at undergraduate institutions, published as "Academic Excellence: The Sourcebook," provided updated information on science degrees and the baccalaureate origins of Ph.D.s. These data make it evident that there is significant variation in the ratio of bachelor's degrees to Ph.D.s. Also noteworthy is that institutions with large enrollments and relatively large numbers of students can produce a greater number of students who obtain their Ph.D. degrees than many smaller institutions. When current findings are compared with those from the 1980s, it is evident that fully two-thirds of the institutions studied lost ground in terms of the ratio of bachelor's degrees to Ph.D.s. Some limitations of the data available are noted. (SLD)

The Tyranny of Small Numbers

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1

Research Corporation SPECIAL REPORT

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ACADEMIC EXCELLENCE

A study of the role of research in the natural sciences at undergraduate institutions

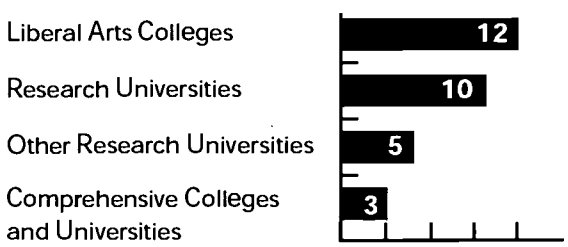
The Tyranny of Small Numbers

One of the strongest arguments made to attract increased support for science for undergraduate liberal arts colleges in the mid-to-late 1980s was that the proportion of students obtaining their Ph.D. degrees was larger at these institutions than at their Ph.D.-granting university counterparts. This argument was catalyzed by comparisons of Ph.D. degree production from bachelors degree graduates of colleges and universities published by Alfred Hall (1) and by the distribution of "Baccalaureate Sources of Ph.D.'s: Rankings According to Institution of Origin" from Franklin and Marshall College beginning in 1975 (2) with regular updates. However, this concept took on a new form in 1985 with the report of Carol H. Fuller for the Great Lakes Colleges Association entitled "An Analysis of Leading Undergraduate Sources of Ph.D.'s, Adjusted for Institutional Size."(3) The Fuller Report influenced both the Oberlin Reports (4,5) and the initial efforts of Project Kaliedoscope (6). The bottom line was the understanding that liberal arts colleges produced significantly more students who obtained the Ph.D. *per unit population* than did research universities, other doctoral universities, and comprehensive colleges and universities. But is this conclusion justified, and is it meaningful? And has it changed from the original 1980s assessment?

Quotes from Previous Studies

A selected set of 48 relatively small, independent, four-year colleges of the liberal arts and sciences have continually produced outstanding graduates, with unusually high proportions . . . of graduates subsequently going on to the doctorate and careers in scientific fields. (Ref. 4, pg. 9)

Small, independent liberal arts institutions . . . their graduates earn Ph.D.'s in science and mathematics at over twice the national average. (Ref. 6, pg. 2)



Natural Science Ph.D.'s Earned by Graduates of Each Type of Institution. Number of Ph.D.'s per 1000 Graduates. (Ref.6, pg. 3)

Ph.D.s originating from Study institutions

The recent data compilation for the natural sciences at undergraduate institutions, included in *Academic Excellence: The SourceBook*, provided updated information on science degrees and baccalaureate origins of Ph.D.s. Here individual institutions were compared using public information. Table 1 presents the number of Ph.D.s in astronomy, chemistry, geosciences, physics, and the biological sciences with baccalaureate origins at the Study institutions for three three-year periods for which the data were available (7), the number of science baccalaureate degrees from the same institutions for a comparable three-year period six years earlier, and the ratio of baccalaureate degrees to Ph.D.s. The Survey institutions had the following summary characteristics:

Doctorates in	**1991–93**	**1994–96**	**1997–99**
Doctorates, 3-year period	2,787	2,947	3,209
Baccalaureates in	**1985–87**	**1988–90**	**1991–93**
Science Baccalaureates, 3-year period	24,736	22,432	25,480
Ratio (Baccalaureates/Doctorates)	8.88	7.61	7.94

What is clearly evident from Table 1 is that, with few exceptions, there is significant variation in the numbers, even for well-recognized institutions.

Table 1. Number of Doctorate Alumni in Astronomy, Chemistry, GeoSciences, Physics, and Biological Sciences by Baccalaureates Produced Six Years Earlier in the Same Disciplines **
(Figure 2.10, *The SourceBook*)

Academic Institution	Class	Type	Doctorates 1991-1993	Science Baccalaureates 1985-1987	Ratio A *	Doctorates 1994-1996	Science Baccalaureates 1988-1990	Ratio B *	Doctorates 1997-1999	Science Baccalaureates 1991-1993	Ratio C *
Harvey Mudd College	B	P	47	105	2.2	48	125	2.6	68	142	2.1
Swarthmore College	B	P	62	155	2.5	71	137	1.9	65	158	2.4
University of San Diego	A	P	6	99	16.5	6	104	17.3	53	143	2.7
Carleton College	B	P	108	318	2.9	93	269	2.9	82	268	3.3
Reed College	B	P	71	195	2.7	51	156	3.1	61	207	3.4
Wesleyan University	B	P	43	198	4.6	43	143	3.3	45	174	3.9
Bates College	B	P	31	176	5.7	33	183	5.5	39	152	3.9
Kalamazoo College	B	P	39	163	4.2	32	150	4.7	37	145	3.9
Pomona College	B	P	42	154	3.7	27	125	4.6	33	133	4.0
Morehouse College	B	P	5	98	19.6	1	40	40.0	10	41	4.1
Oberlin College	B	P	68	270	4.0	75	272	3.6	83	354	4.3
Wabash College	B	P	22	135	6.1	23	111	4.8	25	110	4.4
Williams College	B	P	51	223	4.4	34	202	5.9	52	233	4.5
Bryn Mawr College	A	P	23	138	6.0	27	126	4.7	29	133	4.6
Trinity College	B	P	18	132	7.3	20	112	5.6	24	111	4.6
Haverford College	B	P	36	155	4.3	38	156	4.1	40	186	4.7
Beloit College	B	P	26	113	4.3	25	106	4.2	18	86	4.8
Mount Holyoke College	B	P	41	253	6.2	38	204	5.4	49	235	4.8
Macalester College	B	P	22	121	5.5	22	98	4.5	25	122	4.9
Trinity University	B	P	13	159	12.2	29	144	5.0	39	192	4.9
Ithaca College	B	P	5	105	21.0	13	94	7.2	22	109	5.0
Franklin and Marshall College	B	P	28	262	9.4	35	187	5.3	37	185	5.0
College of William and Mary	A	S	73	479	6.6	90	418	4.6	111	561	5.1
Texas Lutheran University	B	P	6	58	9.7	15	45	3.0	14	71	5.1
College of Wooster	B	P	42	166	4.0	33	138	4.2	32	164	5.1
Juniata College	B	P	25	185	7.4	22	155	7.0	27	139	5.1
Grinnell College	B	P	44	169	3.8	44	174	4.0	33	174	5.3
Wellesley College	B	P	28	180	6.4	33	181	5.5	42	223	5.3
Whitman College	B	P	20	164	8.2	26	126	4.8	25	138	5.5
Allegheny College	B	P	41	244	6.0	32	202	6.3	33	186	5.6
University of Dayton	A	P	21	181	8.6	39	135	3.5	23	130	5.7
Calvin College	B	P	25	177	7.1	29	181	6.2	29	167	5.8
Smith College	B	P	38	245	6.4	38	191	5.0	38	219	5.8
Earlham College	B	P	33	152	4.6	19	123	6.5	25	146	5.8
Rochester Institute of Technology	A	P	25	170	6.8	46	255	5.5	45	264	5.9
Barnard College	B	P	16	180	11.3	16	141	8.8	17	101	5.9
Chatham College	B	P	4	37	9.3	6	25	4.2	4	24	6.0
Lake Forest College	B	P	4	84	21.0	7	73	10.4	8	48	6.0
Bowdoin College	B	P	27	212	7.9	38	197	5.2	32	194	6.1
College of the Holy Cross	B	P	14	277	19.8	24	198	8.3	31	189	6.1
Middlebury College	B	P	25	225	9.0	29	187	6.4	30	185	6.2
Rose-Hulman Institute of Technology	A	P	5	43	8.6	12	44	3.7	13	82	6.3
Illinois Wesleyan University	B	P	15	139	9.3	9	130	14.4	25	166	6.6
Bucknell University	A	P	36	283	7.9	48	292	6.1	47	313	6.7
Lawrence University	B	P	15	121	8.1	26	118	4.5	26	178	6.8
Ripon College	B	P	15	74	4.9	15	64	4.3	11	76	6.9
Furman University	A	P	23	177	7.7	23	192	8.3	36	249	6.9

Table 1 (cont.). Number of Doctorate Alumni in Astronomy, Chemistry, GeoSciences, Physics, and Biological Sciences by Baccalaureates Produced Six Years Earlier in the Same Disciplines (Figure 2.10, *The SourceBook*)

Academic Institution	Class	Type	Doctorates 1991-1993	Science Baccalaureates 1985-1987	Ratio A *	Doctorates 1994-1996	Science Baccalaureates 1988-1990	Ratio B *	Doctorates 1997-1999	Science Baccalaureates 1991-1993	Ratio C *
Hope College	B	P	41	237	5.8	34	226	6.6	33	233	7.1
Dickinson College	B	P	20	150	7.5	10	111	11.1	19	135	7.1
Knox College	B	P	14	126	9.0	22	125	5.7	16	114	7.1
Occidental College	B	P	31	181	5.8	32	192	6.0	31	223	7.2
Hendrix College	B	P	16	167	10.4	22	135	6.1	19	142	7.5
Ohio Wesleyan University	B	P	13	86	6.6	13	80	6.2	15	113	7.5
Connecticut College	B	P	14	139	9.9	16	111	6.9	14	107	7.6
Willamette University	B	P	9	79	8.8	13	129	9.9	15	115	7.7
Colorado College	B	P	19	233	12.3	36	235	6.5	32	253	7.9
Gustavus Adolphus College	B	P	22	244	11.1	20	234	11.7	32	255	8.0
Skidmore College	B	P	11	150	13.6	12	96	8.0	13	104	8.0
Wheaton College	B	P	16	180	11.3	18	151	8.4	17	136	8.0
Davidson College	B	P	19	108	5.7	19	120	6.3	19	155	8.2
Santa Clara University	B	P	21	113	5.4	15	127	8.5	18	147	8.2
Lafayette College	B	P	25	183	7.3	27	174	6.4	23	189	8.2
Colby College	B	P	23	187	8.1	20	168	8.4	23	192	8.3
Fort Lewis College	B	S	15	192	12.8	16	154	9.6	19	159	8.4
Lewis and Clark College	B	P	17	123	7.2	11	87	7.9	13	112	8.6
University of Puget Sound	B	P	22	125	5.7	15	161	10.7	19	169	8.9
Hamilton College	B	P	22	85	3.9	17	80	4.7	13	116	8.9
Centre College	B	P	10	82	8.2	14	109	7.8	13	117	9.0
Goucher College	B	P	8	68	8.5	8	28	3.5	7	63	9.0
Washington and Lee University	B	P	8	91	11.4	8	123	15.4	16	144	9.0
Colgate University	B	P	41	318	7.8	37	218	5.9	29	263	9.1
Western Kentucky University	A	S	16	233	14.6	14	207	14.8	31	286	9.2
Canisius College	B	P	18	144	8.0	20	131	6.6	15	140	9.3
John Carroll University	A	P	15	183	12.2	17	187	11.0	21	197	9.4
Humboldt State University	A	S	43	476	11.1	39	268	6.9	37	348	9.4
DePauw University	B	P	15	194	12.9	17	178	10.5	16	152	9.5
University of Wisconsin - Stevens Point	B	S	26	283	10.9	24	307	12.8	39	376	9.6
James Madison University	A	S	17	252	14.8	25	249	10.0	32	312	9.8
Cal. Poly. State U - San Luis Obispo	A	S	36	412	11.4	35	423	12.1	57	558	9.8
University of Northern Iowa	A	S	18	236	13.1	14	233	16.6	26	257	9.9
University of St.Thomas	A	P	8	131	16.4	9	96	10.7	11	109	9.9
Northern Arizona University	A	S	20	340	17.0	24	305	12.7	28	290	10.4
Union College	B	P	22	209	9.5	23	180	7.8	19	197	10.4
Western Washington University	A	S	20	245	12.3	29	198	6.8	24	249	10.4
University of Richmond	A	P	13	163	12.5	15	171	11.4	17	180	10.6
Wake Forest University	A	P	33	327	9.9	42	281	6.7	30	326	10.9
University of Wisconsin-Eau Claire	A	S	29	266	9.2	23	293	12.7	28	306	10.9
Gettysburg College	B	P	18	130	7.2	11	109	9.9	13	145	11.2
Luther College	B	P	13	175	13.5	14	190	13.6	19	213	11.2
Hartwick College	B	P	12	88	7.3	11	76	6.9	8	90	11.3
Southwest Missouri State University	A	S	20	224	11.2	31	210	6.8	24	270	11.3
Gonzaga University	B	P	6	81	13.5	8	68	8.5	7	79	11.3
Pacific Lutheran University	B	P	9	155	17.2	17	181	10.6	19	218	11.5
University of Minnesota - Duluth	A	S	13	326	25.1	19	247	13.0	24	276	11.5

Table 1 (cont.). Number of Doctorate Alumni in Astronomy, Chemistry, GeoSciences, Physics, and Biological Sciences by Baccalaureates Produced Six Years Earlier in the Same Disciplines (Figure 2.10, *The SourceBook*)

Academic Institution	Class	Type	Doctorates 1991-1993	Science Baccalaureates 1985-1987	Ratio A *	Doctorates 1994-1996	Science Baccalaureates 1988-1990	Ratio B *	Doctorates 1997-1999	Science Baccalaureates 1991-1993	Ratio C *
SUNY College at Geneseo	B	S	15	277	18.5	24	259	10.8	24	277	11.5
University of North Florida	B	S	3	25	8.3	0	52	NA	6	70	11.7
Spelman College	B	P	1	106	106.0	9	112	12.4	13	153	11.8
Southwestern University	B	P	5	64	12.8	6	79	13.2	9	108	12.0
University of Central Arkansas	A	S	5	86	17.2	8	70	8.8	7	85	12.1
San Jose State University	A	S	22	501	22.8	34	414	12.2	35	447	12.8
California State University, Long Beach	A	S	23	489	21.3	33	470	14.2	31	404	13.0
University of Puerto Rico, Mayaguez	A	S	19	401	21.1	22	344	15.6	34	447	13.1
Fairfield University	B	P	11	189	17.2	15	186	12.4	15	198	13.2
Mississippi College	B	P	6	70	11.7	4	58	14.5	6	85	14.2
Centenary College of Louisiana	B	P	2	99	49.5	3	73	24.3	6	88	14.7
Towson University	A	S	9	176	19.6	14	207	14.8	18	266	14.8
Drury University	B	P	3	62	20.7	2	94	47.0	7	109	15.6
Texas Wesleyan University	B	P	1	43	43.0	4	38	9.5	2	32	16.0
Southwest Texas State University	A	S	9	164	18.2	13	193	14.8	14	231	16.5
Creighton University	B	P	18	294	16.3	20	270	13.5	19	314	16.5
Southern Illinois U. at Edwardsville	A	S	16	219	13.7	12	199	16.6	15	252	16.8
Eastern Michigan University	A	S	17	359	21.1	21	360	17.1	21	356	17.0
Mount Saint Mary's College	B	P	1	18	18.0	0	23	NA	2	34	17.0
Denison University	B	P	10	174	17.4	11	150	13.6	9	154	17.1
University of Scranton	A	P	23	373	16.2	20	379	19.0	19	330	17.4
Central Michigan University	A	S	14	410	29.3	28	400	14.3	23	402	17.5
University of Tennessee, Chattanooga	B	S	9	188	20.9	10	159	15.9	10	177	17.7
University of North Carolina, Asheville	B	S	3	54	18.0	7	73	10.4	6	110	18.3
Augustana College	B	P	17	211	12.4	21	228	10.9	16	297	18.6
St. Lawrence University	B	P	32	237	7.4	21	196	9.3	13	247	19.0
Eastern Illinois University	A	S	15	374	24.9	27	325	12.0	18	346	19.2
Austin College	B	P	8	112	14.0	7	121	17.3	7	137	19.6
College of St. Benedict / St. John's U.	B	P	31	192	12.0	20	144	13.7	32	191	19.9
College of Charleston	A	S	20	275	13.8	15	234	15.6	21	422	20.1
Coe College	B	P	8	65	8.1	5	58	11.6	3	62	20.7
Central Washington University	A	S	4	199	49.8	5	167	33.4	9	188	20.9
Fordham University	A	P	22	252	11.5	19	183	9.6	7	149	21.3
Linfield College	B	P	8	69	8.6	4	38	9.5	3	64	21.3
Northern Kentucky University	B	S	9	146	16.2	6	103	17.2	6	133	22.2
Randolph-Macon College	B	P	8	62	7.8	4	53	13.3	3	70	23.3
Dillard University	B	P	0	85	NA	1	57	57.0	3	71	23.7
Butler University	B	P	14	111	7.9	13	76	5.8	4	106	26.5
University of the Pacific	A	P	8	106	13.3	6	81	13.5	3	81	27.0
Middle Tennessee State University	A	S	9	244	27.1	10	199	19.9	3	253	84.3
University of Portland	B	P	5	44	8.8	4	51	12.8	1	95	95.0
Coastal Carolina University	B	S	0	42	NA	0	65	NA	0	103	NA
* Ratios A, B and C represent number of baccalaureates awarded per doctorate awarded to an alumni six years later.											
**Data sorted on Ratio C.											

Harvey Mudd College, a leading science institution, shows very stable ratios even with a record of nearly 50 percent growth in the number of science majors. On the other hand, Barnard College shows a significant decrease in the ratio of science majors to Ph.D. recipients, but the number of persons obtaining the Ph.D. degree remained constant during the nine-year period.

Ratios higher at large institutions

Also noteworthy is the fact that institutions with large enrollments and relatively large numbers of science majors can produce a greater number of students who obtain their Ph.D. degrees than many smaller institutions whose ratios of baccalaureate majors to Ph.D. recipients is very low. Thus, for example, San Jose State University (Ratio C = 12.8) and Eastern Michigan University (Ratio C = 17.0) together produced more students who obtained their Ph.D. degrees in the natural sciences than the University of Richmond (Ratio C = 10.6), the University of St. Thomas (Ratio C = 9.9), Lake Forest College (Ratio C = 6.0), and Texas Lutheran University (Ratio C = 5.1) combined. Indeed, San Jose State was the baccalaureate origin of more students who obtained the Ph.D. in the natural sciences than Bates College, Beloit College, Trinity University, and a host of other institutions in this table.

Trends are also evident from the data. For example, the University of San Diego, like Ithaca College, Trinity University, and University of Minnesota–Duluth have experienced significant growth in the number of their students who obtained their Ph.D. degrees during the survey period. Alternatively, Colgate University, St. Lawrence University, and Fordham University experienced a decline in these numbers.

Since data are available for 1951–1980 Ph.D. productivity from Carol Fuller's report along with average annual baccalaureate degrees conferred for 1946–1976 (3), we can compare pre-1980 data with data from the 1990s for the institutions included in both data sets. The ratios being calculated are

$$\frac{\text{Total number of bachelors-degree graduates for the period}}{\text{Total number of science Ph.D. graduates for the period}}$$

For data from the Fuller Report we have only used Ph.D. degrees in the "empirical and life sciences" which is directly comparable to the Ph.D. degree accounting in Table 1. This pre-1980 and post-1990 data are given in Table 2 for thirty institutions. The number in parentheses is the ratio of the number of science baccalaureate degrees for 1985–1993 from Table 1 divided by the total num-

Table 2. Comparison of ratios of science baccalaureate degrees to science Ph.D. degrees for years pre-1980 and post-1990. The lower the number the higher is the proportion of students who obtain their Ph.D. degrees. (See text for explanation.)

INSTITUTION	PRE-1980 RATIO	POST-1990 RATIO
Harvey Mudd College	6.71	6.33 (2.28)
Swarthmore College	12.1	15.2 (2.27)
Carleton College	17.0	10.4 (3.02)
Reed College	7.83	11.9 (3.05)
Wesleyan University	25.4	44.2 (3.93)
Kalamazoo College	19.5	21.2 (4.24)
Pomona College	16.3	27.1 (4.04)
Oberlin College	18.4	39.5 (5.93)
Wabash College	15.7	23.9 (5.09)
Williams College	26.6	30.4 (4.80)
Bryn Mawr College	31.3	30.6 (5.02)
Haverford College	13.4	21.3 (4.36)
Beloit College	35.9	27.4 (4.42)
Macalester College	70.0	43.7 (4.94)
Franklin and Marshall College	24.4	37.7 (6.34)
College of Wooster	23.3	29.2 (4.37)
Grinnell College	24.5	22.6 (4.27)
Wellesley College	61.8	47.2 (5.67)
Earlham College	23.0	26.4 (5.46)
Barnard College	54.0	95.7 (8.61)
Lake Forest College	89.1	112 (10.8)
Bowdoin College	27.9	31.4 (6.21)
Hope College	32.2	40.5 (6.44)
Knox College	30.2	36.5 (7.02)
Occidental College	38.3	32.2 (6.34)
Ohio Wesleyan University	149	79.5 (8.11)
Colorado College	46.2	45.8 (8.28)
Davidson College	31.2	49.0 (6.72)
Hamilton College	37.6	60.0 (5.40)
DePauw University	41.1	95.8 (10.9)

Table 3. Comparison of annual average science Ph.D. degrees for years pre-1980 and post-1990. The numbers are of students per year who graduated from the institution who, on average, obtained their Ph.D. degrees in the natural sciences during 1951–1980 (pre-1980) and during 1991–1999 (post-1990). Numbers in parentheses are the total number of Ph.D. recipients in the natural sciences for the period.

INSTITUTION	PRE-1980	POST-1990
Harvey Mudd College	7.8 (235)	18 (163)
Swarthmore College	19 (560)	22 (198)
Carleton College	14 (426)	31 (283)
Reed College	16 (488)	20 (183)
Wesleyan University	9.3 (278)	15 (131)
Kalamazoo College	7.8 (235)	12 (108)
Pomona College	16 (478)	11 (102)
Oberlin College	24 (710)	37 (334)
Wabash College	8.2 (246)	7.8 (70)
Williams College	11 (318)	15 (137)
Bryn Mawr College	5.3 (158)	8.8 (79)
Haverford College	9.1 (272)	13 (114)
Beloit College	5.9 (178)	7.7 (69)
Macalester College	4.4 (132)	7.7 (69)
Franklin and Marshall College	13 (384)	11 (100)
College of Wooster	12 (358)	12 (107)
Grinnell College	8.4 (252)	13 (121)
Wellesley College	6.4 (192)	11 (103)
Earlham College	7.5 (226)	8.6 (77)
Barnard College	7.6 (227)	5.4 (49)
Lake Forest College	2.1 (63)	2.1 (19)
Bowdoin College	7.8 (234)	11 (97)
Hope College	8.2 (247)	12 (108)
Knox College	7.5 (224)	5.8 (52)
Occidental College	8.2 (247)	10 (94)
Ohio Wesleyan University	7.5 (224)	4.6 (41)
Colorado College	5.5 (166)	9.7 (87)
Davidson College	6.5 (194)	6.3 (57)
Hamilton College	4.8 (144)	5.8 (52)
DePauw University	7.1 (214)	5.3 (48)

ber of science Ph.D. degrees for 1991–1999. That number divided by the percentage of science degrees at that institution for 1985–1997 (8) gives the post-1990 Ratio that is comparable to the pre-1980 Ratio.

Change in the wrong direction?

Has there been any change from pre-1980s to post-1990 — two periods approximately bordered by the Oberlin Conferences? New private and federal funding programs directed to these institutions were instituted in the mid- to late-1980s, and there was increased attention to creating environments that encouraged students to enter graduate school. The answer provided from Table 2 is that "yes, there has been change, but in a direction that is opposite to that intended." Harvey Mudd College continues to stand out as exceptional as the baccalaureate origin of science Ph.D.s, but fully two-thirds of the institutions from Table 2 lost ground in this endeavor. For some, like Carleton College and Macalester College, the change towards serving as the baccalaureate origin of science Ph.D.s has been spectacular, and one should ask what factors were responsible for this change. For others, like Oberlin College and Franklin and Marshall College the change has been away from serving in this capacity, or has it?

Table 3 provides the annual average number of science Ph.D.s whose baccalaureate origin was the institution that is specified. The total number of Ph.D. degrees from the period is in parentheses. Here a different view of these institutions emerges. Carleton College and Oberlin College stand out as truly exceptional, both in serving as the baccalaureate origin of Ph.D.s in the natural sciences and in the growth in the number of these graduates from pre-1980 to post-1990. Despite growth in enrollment in the institutions of Table 3 from pre-1980 to post-1990, only two-thirds of the schools listed had an increase in the number of students annually who obtain their science Ph.D. degrees.

Questions still remain

There are significant questions that remain unanswered here. Did the significant infusion of research support have any real impact on the total number of students who left these institutions for graduate school in the sciences? What factor(s) propelled schools like Carleton College to become a major producer of science Ph.D. degrees in the 1990s? And what does "major producer" signify when the "top 25 research universities" produced five times more students who obtained their Ph.D. degrees in the physical and biological sciences than do the "top 25 baccalaureate colleges?" (9) A variety of questions regarding the role of undergraduate institutions in the preparation of students for scientific careers remain, but many of those related to baccalaureate origins are now more clearly defined. One should not categorize groups of institutions together without taking account of the broad diversity of the individual contributors. Small numbers are not statistically relevant, and the sum of small numbers merely averages small differences.

—MICHAEL P. DOYLE

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Faculty Surveys Will Reveal Significant Concerns

The abstracting of faculty surveys, similar to that done for institutional surveys and published in *The Sourcebook*, is nearing completion and is planned for publication in the fall of 2002. Over 2,900 individual faculty survey responses have been read, and pertinent information culled, to determine the specific concerns of faculty in the same categories as those used for the institutional responses. Both the faculty and the institutional responses will be included in a bound volume that will be available for distribution and sale this fall. Institutions who participated in the *Academic Excellence* study will receive a copy as soon as the volume is available.

There are parallels in concerns from the institutions and their faculty about time pressures, but there are also some surprising discrepancies. Misconceptions are abundant, and few institutions are immune from justifiable criticisms.

ACADEMIC EXCELLENCE

Results from a comprehensive study of the environment for research in the natural sciences at predominantly undergraduate colleges and universities have been published in *Academic Excellence: The SourceBook*—539 pages of data and opinions which constitute an important resource for defining the current status of the natural sciences at the 136 surveyed institutions and in the broader universe of undergraduate institutions. These schools have served as a national resource for a significant proportion of students who undertake professional careers in the sciences, and a primary reason cited for their output has been the research experiences of undergraduate students with faculty mentors.

However, prior to this study there was a growing perception that resources and productivity were declining. Concern over these perceived trends by five private foundations with interests in the natural sciences (Research Corporation, the M. J. Murdock Charitable Trust, the W. M. Keck Foundation, the Welch Foundation, and the Camille and Henry Dreyfus Foundation, Inc.) prompted the intensive data collection and analyses for *Academic Excellence: A Study of the Role of Research in the Natural Sciences at Undergraduate Institutions.*

Copies of *The SourceBook* are available from Research Corporation. Orders must be prepaid by check or money order; $50.00, includes priority rate postage.

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